LNG Safety Research: FEM3A Model Development

Quarterly Report
07-01-06 to 09-30-06

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ABSTRACT
This quarterly report for DE-FG26-04NT42030 covers a period from July 1, 2006 to October 31, 2006. GTI's activities during the report quarter were limited to administrative work. The work at the University of Arkansas continued in line with the initial scope of work and the identified questions regarding surface to cloud heat transfer as being largely responsible for the instability problems previously encountered. A brief summary of results is discussed in this section and the complete report from University of Arkansas is attached.

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EXECUTIVE SUMMARY
All work planned for this project has been completed. Specifically:

Task A – Simulation of Low-Wind-Speed Stable Atmospheric Conditions:
This task has been completed, and a new version of FEM3A will be received by GTI.

Task B – Verification for Dispersion over Rough Surfaces With and Without Obstacles:
This task has been completed, and a new version of FEM3A will be received by GTI.

Task C – Adapting the FEM3A Model for More General Application
This task was obviated when DOE redirected the contract near the project mid-point.

Task D - Provide assistance and wind tunnel data to DOE for FLUENT development

This task has been completed and data requested by DOE-NETL has been delivered.

Researchers at the University of Arkansas are preparing the final report that will be received by GTI by November 30, 2006.

EXPERIMENTAL

Researchers at the University of Arkansas have completed all measurements of wind tunnel turbulence and concentration data requested by representatives from DOE–NETL, and have provided them to Mr. David Huckaby, NETL. This completes contract requirements agreed to with DOE-NETL.

RESULTS AND DISCUSSION

Researchers at the University of Arkansas have completed verification of FEM3A for application under all anticipated wind speed and atmospheric stability conditions. A new version of FEM3A which uses the k-epsilon turbulence closure model to handle dense gas dispersion effects is being submitted to GTI. This completes contract requirements with respect to the FEM3A model.

CONCLUSION

The work under this contract has been completed. The final report will be delivered on time.

Vapor Dispersion and Thermal Hazard Modeling

Tenth Quarterly Report
(July - September, 2006)

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For

GAS TECHNOLOGY INSTITUTE
Contract No. 4GTI-DE-FG26-04NT42030 (Prime)
K100029184 (Subcontract)

GTI Project Manager
Iraj Salehi

October 31, 2006

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1.0 RESEARCH SUMMARY

Title	Vapor Dispersion and Thermal Hazard Modeling
Contractor	University of Arkansas GTI Contract Number: K100029184
Principal Investigators	Jerry Havens Tom Spicer
Contract Period	April 2004 – March 2006 No Cost Extension granted to September 30, 2006
Objectives	1. To develop the FEM3A model for application to general scenarios involving dispersion problems with obstacles and terrain features of realistic complexity, and for very low wind speed, stable weather conditions as required for LNG vapor dispersion application specified in 49 CFR 193 and NFPA 59A. 2. To provide additional wind-tunnel dense gas dispersion data that can be used for verification of computational fluid dynamics (CFD) computer models for predicting LNG vapor dispersion influenced by terrain features and or obstacles, and to provide assistance to DOE in its consideration of FLUENT as an recommended alternative (to FEM3A) CFD model for approval by the DOT Administrator under 49 CFR 193 and NFPA 59A.
Technical Perspective	The dispersion model DEGADIS specified in 49 CFR 193 is limited to application for dispersion over smooth, level terrain free of obstacles such as buildings, tanks, or dikes. There is a critical need for a dispersion model that allows consideration of the effects of terrain features and obstacles on the dispersion of LNG vapor clouds. This program will contribute to the further development of any CFD model by providing wind tunnel data for model verification.
Project Milestones	A. Simulation with FEM3A of low-wind-speed, stable atmospheric conditions

B. Verification for dispersion over rough surfaces, with and without obstacles.
C. Adapting the FEM3A model for more general application.
D. Provide assistance and wind tunnel data to DOE for their consideration of FLUENT as an alternative (to FEM3A) model.

Results for Quarter 10

We have completed verification of FEM3A for application under all anticipated wind speed and atmospheric stability conditions. A new version of FEM3A which uses the k-epsilon turbulence closure model to handle dense gas dispersion effects is being submitted to GTI. This completes contract requirements with respect to the FEM3A model.

We have completed all measurements of wind tunnel turbulence and concentration data requested by representatives from DOE–NETL, and have provided them to Mr. David Huckaby, NETL. This completes contract requirements agreed to with DOE-NETL.

The final report will be delivered by November 30, 2006

2.0 PROGRAM OBJECTIVE

The original objective of this research was to further develop the FEM3A dispersion model for application to general scenarios involving dispersion problems with obstacle and terrain features of realistic complexity, and for very low wind speed, stable weather conditions as required for LNG vapor dispersion application in 49 CFR 193. Near the mid-point of the contract period, DOE redirected the primary effort to provide CHRC's assistance to DOE-NETL in their consideration of the FLUENT CFD model as an alternative (to FEM3A) model for use under 49 CFR 193. The original program involved three principal tasks, and a fourth task was added regarding wind tunnel experiment assistance to DOE in their evaluation of FLUENT.

Task A – Simulation of Low-Wind-Speed Stable Atmospheric Conditions

This task has been completed, and a new version of FEM3A is being sent to GTI.

Task B – Verification for Dispersion over Rough Surfaces With and Without Obstacles

This task has been completed, and a new version of FEM3A is being sent to GTI.

Task C – Adapting the FEM3A Model for More General Application

This task was obviated when DOE redirected the contract near the mid-point (see Objective above).

Task D - Provide assistance and wind tunnel data to DOE for FLUENT development

This task has been completed and data requested by DOE-NETL has been delivered.

3.0 PROGRAM TIME SCHEDULE

All tasks in the program were completed during Quarter 10.

4.0 WORK PERFORMED DURING JULY- SEPTEMBER 2006 (QUARTER 10)

We have completed verification of FEM3A for application under all anticipated wind speed and atmospheric stability conditions. A new version of FEM3A which uses the k-epsilon turbulence closure model to handle dense gas dispersion effects is being submitted to GTI. This completes contract requirements with respect to the FEM3A model.

We have completed all measurements of wind tunnel turbulence and concentration data requested by representatives from DOE–NETL, and have provided them to Mr. David Huckaby, NETL. This completes contract requirements agreed to with DOE-NETL.

The final report will be delivered, on schedule, by November 30, 2006